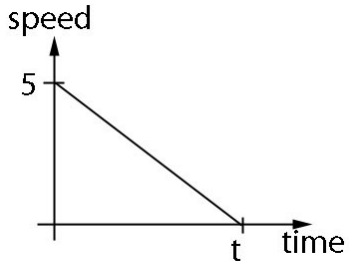
Solutions for Sec 3E Pure Physics MYE 2011

Paper 1

Qn	Ans	Explanations
1	D	Vernier calipers : To measure the internal and external diameter of the pipe (2 cm) Measuring tape: To measure the length of pipe (several metres)
2	B	Reading = Main scale + Micrometer scale = 2.5 + 0.23 = 2.73 mm
3	B	Smallest reading (precision) of the micrometer is 0.01 cm (2 d.p.)
4	C	Mass is a scalar (magnitude only), whereas weight is a force, which is a vector (magnitude and direction)
5	B	If the tape is pulled quickly, the dots will be far apart, and close together when it is pulled slowly. Therefore, we'd expect the dots to be far apart, close together, then far apart.
6	A	Grace takes 3 minutes to walk to school. Convert 3 minutes to seconds. (3 minutes = 180 seconds) $\text{average speed} = \frac{\text{total distance}}{\text{total time taken}} = \frac{(50+80+20)}{180} = \frac{150}{180} = 0.83\, m/s$
7	C	The speed is constant between 3 and 5 s. Therefore the acceleration is zero.
8	B	Distance travelled = Area under graph = Area of trapezium $= \frac{1}{2} \times 10 \times (2+7)$ $= \frac{1}{2} \times 10 \times 9$ $= 45m$
9	B	The speed increases initially due to gravity, and then it reaches terminal velocity (constant)
10	B	Draw a simple sketch of the speed time graph.  Recall that: distance travelled = area under graph $3 = \frac{1}{2} \times t \times 5$ $3 = 2.5t$ $t = \frac{3}{2.5} = 1.2s$
11	C	Newton's First Law states that an object in motion will remain in motion (at a uniform/constant speed) unless an external force (resultant force) acts on it. Thus when the forces are balanced (i.e. no resultant force), the velocity is constant. If the forces are unbalanced, the object accelerates (i.e. velocity changes)
12	C	Since the parachutist is falling at a constant speed, the forces must be balanced.
13	A	
14	B	Resultant force = 60 – 20 = 40 N $a = \frac{F}{m} = \frac{40}{25} = 1.6 ms^{-2}$

15 C Resultant force = 10 – 4 = 6 N

$$a = \frac{F}{m} = \frac{6}{2} = 3ms^{-2}$$

The block of wood thus moves with a constant acceleration of 3 m/s^2.

16 D Since the mass of trolley **X** is twice the mass of trolley **Y**, it will have ½ the acceleration compared to trolley **Y**. Thus initial acceleration of trolley **Y** is 2 x 2 = 4 m/s^2.

17 D Minimum resultant force = 12 – 10 = 2 N (when the forces act in opposite directions)
Maximum resultant force = 12 + 10 = 22 N (when the forces act in the same direction)

18 B The mass of the rock does not change (remains 10 kg) on the Moon.

19 C

20 B

21 B The spring balance measures the weight of the object. Since both readings are 3 N, they have the same weight. Given that they are both in the same gravitational field (eg. On Earth), they should have the same mass as well. However, their volumes are different, and **Y** is bigger in size compared to **X**.

22 A P has a stronger gravitational field, as the gradient of the graph gives the value of g (from the formula $W = mg$)

23 B $$density = \frac{mass}{volume} = \frac{(220-40)}{(5\times 6\times 4)} \text{g/cm}^3$$

24 A The simple balance shows that both **X** and **Y** have the same mass.

Applying the formula $density = \frac{mass}{volume}$, we find that the density of **X** = ½ x Density of **Y**

25 A

26 B Apply the Principle of Moments,

$$CWM = ACWM$$

$$F \times 3 = 10 \times 6$$

$$F = \frac{10\times 6}{3} = 20N$$

27 B The moment given in the diagram = 60N x 30 cm = 1800 Ncm in the anti-clockwise direction. Thus we need a clockwise moment of 1800 Ncm in order to balance the beam.

28 C For Principle of Moments, the sum of the clockwise moments must be equal to the sum of the anti-clockwise moments.

29 A If passengers stand on the upper deck, it would make the centre of gravity of the bus higher, and hence cause the bus to be less stable.

30 A Since the object returns to its original position, it must be in stable equilibrium.

31 A Water stored in the dam is stored as gravitational potential energy. The energy is converted to kinetic energy when it flows through the pipe, and when it turns a generator, it is converted to electrical energy.

32 D Since some of the energy is converted to internal energy (i.e. lost), it should not be able to reach the same height it was released from, but will be at a lower height.

33 C When the block is at the top of the slope, it has GPE = mgh = (2)(10)(10) = 200 J
When it slides to the bottom, all of the GPE will be converted to KE, hence it has 200 J of KE.

34 A Work done = F x s = 300 x 3 = 900 J

$$\text{Power} = \frac{\text{Work done}}{\text{time taken}} = \frac{900}{20} = 45W$$

35 A By the formula $pressure = \frac{force}{area}$, the larger the area, the lesser the pressure.

36 C The height of the mercury column is affected by the atmospheric pressure, which is given by the formula $p = h\rho g$

37 C $p = h\rho g = (0.75m)(13600)(10) = 102\,000\,Pa$

38 D If the liquid is less dense, we need more liquid to exert the same pressure as a denser liquid on the right side.

39 D The pressure increases with the depth, and also increases with the density of the liquid. Hence the pressure deep inside a denser liquid will have a larger pressure.

40 C If liquid 1 has twice the density of liquid 2, then half the volume/height of liquid 1 will exert the same pressure as liquid 2.

Paper 2

SECTION A

1 (a) Average time for 20 oscillations $= \frac{36.49 + 37.01 + 36.91 + 36.94 + 36.56}{5} = 36.782s$

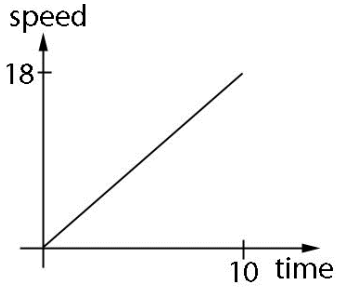
Period, T $= \frac{36.782}{20} = 1.8391 = 1.84s\ (3s.f.)$

(b) 1. **Length of pendulum.** The longer the pendulum, the larger the period of the pendulum.
2. **Gravitation field strength.** The greater the gravitational field strength, the smaller the period of the pendulum.

2 (a) The motorcyclist moves at a constant acceleration of 1.8 m/s^2 during the first 10 s. His speed increases from 0 to 9 m/s in 5s and then 9 to 18 m/s in the next 5s.

(b) $a = \frac{v-u}{t} = \frac{18-9}{5} = 1.8ms^{-2}$

(c)



(i)

(ii) Distance traveled = Area under graph = ½ x 10 x 18 = 90 m

3 (a) Air resistance

(b) (i) 10 m/s^2 (due to gravity)

(ii) As the parachutist falls faster, the amount of air resistance (upward force) acting on him increases, this causes the resultant force to be decreased, hence a decrease in acceleration. (Resultant force = Weight - Air Resistance)

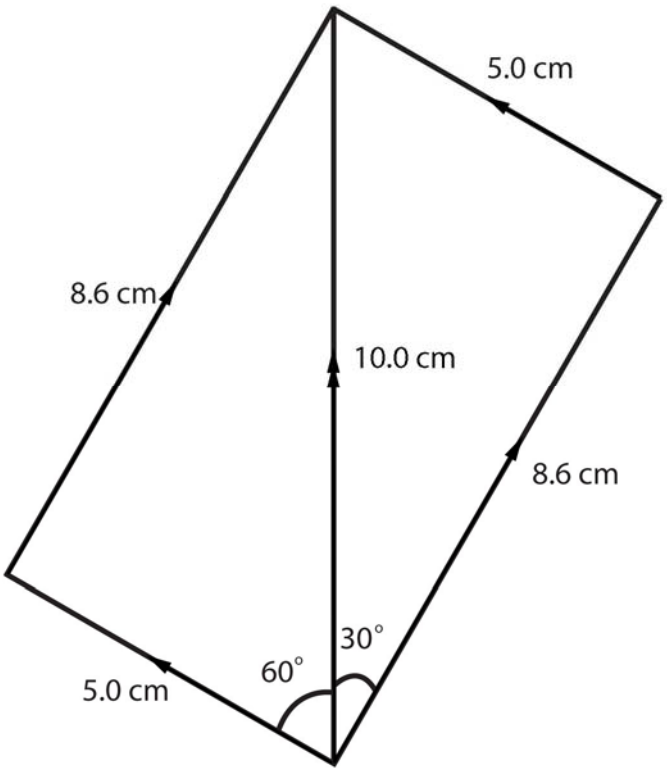
4 (a) $F = ma$

$a = \frac{F}{m} = \frac{5000}{1000} = 5ms^{-2}$

(b) Resultant force, $F = ma = (1000)(3.8) = 3800N$

Since the driving force of the car is 5000 N, the frictional force must be 5000 – 3800 = 1200N.

5



Resultant force = 10.0 N

6 (a) $density = \frac{mass}{volume} = \frac{101}{22} = 4.59\ \text{g/cm}^3$

(b) **C** is made of a different material, as it has a density of 5.6 g/cm^3, which has a different density from **A**, **B** and **D**.

(c) (i) Selenium

(ii) Selenium has a density, which is in between the density of rocks **A**, **B** and **D** (4.59 g/cm^3) and rock **C** (5.6 g/cm^3). Thus when the rocks are placed in liquid Selenium, rocks **A**, **B** and **D** will float, while rock **C** will sink.

7 (a) The Principle of Moments states that for an object in equilibrium, the sum of the clockwise moments about a pivot is equal to the sum of the anti-clockwise moments about the same pivot.

(b) Moment = F x d = 3N x 0.40 m = 1.2 Nm

(c) Applying Principle of Moments,

Total clockwise moments = Total anti-clockwise moments

$$1.2Nm = (2.0N \times 0.3m) + (F \times 0.2m)$$

$$1.2 = 0.6 + 0.2F$$

$$0.2F = 1.2 - 0.6 = 0.6$$

$$F = \frac{0.6}{0.2} = 3N$$

(Note that the distance must be the distance from the pivot!)

8 (a) $\text{Average speed} = \frac{\text{Total distance}}{\text{Total time taken}} = \frac{6.0m}{40s} = 0.15m/s$

(b) $GPE = mgh = (5.0)(10)(2.0) = 100J$

(c) Work done = Gain in GPE = 100 J

$$Power = \frac{W}{t} = \frac{100}{40} = 2.5W$$

(d) The actual output power of the electric motor is higher. This is because there is friction/energy loss in the motor, which means that more work/energy needs to be

supplied than the value calculated in **(c)**.

9 (a) 1. Density of the liquid.
2. Height of the liquid above the particular point.
3. Gravitational field strength.

(b) Since X and Y are at the same horizontal level, they must have the same pressure.
$p_Y = p_x = h\rho g = (0.066)(1000)(10) = 660Pa$

(c) $p_y = h\rho g$

$660 = (0.075)\rho(10)$

$$\rho_{oil} = \frac{660}{(0.075)(10)} = 880\,\text{kg/m}^3$$

SECTION B

10 (a) $$a = \frac{v-u}{t} = \frac{0-14}{3} = -4.67 m/s^2$$
The deceleration of the car is 4.67 m/s^2.

(b) $F = ma = (5.0)(4.67) = 23.3N$

(c) 1. It increases the area of contact
2. It reduces the force of impact.

(d) $$pressure = \frac{force}{area}$$
$force = pressure \times area = 1.4 \times 10^7 \times 0.023 = 3.22 \times 10^5 N$

(e) An object with more mass will have a greater inertia – this means that it will be harder to stop the real passenger. / A real passenger with more mass will also hit the air bag with a greater force, based on the formula F = ma. [acceptable answers must be back with sound explanations.]

11 (a) The Principle of Conservation of Energy states that energy cannot be created or destroyed. It can only be converted from one form of energy to another. The total amount of energy remains constant.

(b) (i) Kinetic energy/Electrical energy to Gravitational Potential Energy
(ii) $GPE = mgh = (0.1)(10)(0.5) = 0.5J$
(iii) Work done = Increase in GPE = 0.5J
$$Power = \frac{W}{t} = \frac{0.5}{1} = 0.5W$$

(c) When the volume of water in **B** is increased, the pressure acting on the base of **B** increases, thus a greater force needs to be exerted, in order to pump more water in. / When the volume of water in **B** increases, the pump needs to raise the water to a higher height, this means that there is more GPE gain by the water, hence more work done/energy needs to be supplied.

(d) As seawater is denser, the weight of seawater (W=mg) will be greater, thus more work is done in moving the same volume of seawater from **A** to **B**.

EITHER

12A (a) (i) $W_{mars} = mg = (0.50)(3.7) = 1.85N$
(ii) 3.7 m/s^2 (Acceleration due to Mars' gravity)
(iii) $W_{earth} = mg = (0.50)(10) = 5.0N$

(b) **A**. Device **A** is a beam balance, which measures the mass of the rock against a standard mass. Since the standard mass has the same mass whether it is on Mars or on Earth, it must balance with the same mass on Mars. [Device **B** is a spring balance, which measures weight, but may have a scale that is used to measure mass. When it is on Mars, the scale needs to be recalibrated before it can be used to measure the mass]

(c) (i) Volume

(ii) Using the displacement method. Tie the rock with a piece of string. Fill a measuring cylinder with some water. Take note of the initial reading of the measuring cylinder. Lower the piece of rock slowly into the water, and ensure that the entire rock is submerged. Take note of the final reading. The volume of the rock is the difference between the final and the initial reading.

[1 mark – Taking note of initial/final reading / 1 mark – Ensuring the entire rock is submerged / 1 mark – Calculating the volume]

[May also use the Eureka can method]

OR

12B (a) (i) $a = \frac{v-t}{t} = \frac{8-0}{3} = 2.67 ms^{-2}$

(ii) $F = ma = (42)(2.67) = 112N$

(iii) Distance travelled = Area under graph = $\frac{1}{2} \times 3 \times 8 = 12m$

(b) Distance traveled from 3 to 14.2 seconds = 100 – 12 = 88m
Distance traveled = Area under graph(trapezium)

$$88 = \frac{1}{2} \times (14.2 - 3.0) \times (8 + v)$$

$$88 = \frac{1}{2} \times 11.2 \times (8 + v)$$

$$88 = 5.6 \times (8 + v)$$

$$8 + v = \frac{88}{5.6} = 15.71$$

$$v = 15.71 - 8$$

$$= 7.71 m/s$$

(c) 1. If there had been a strong wind, the initial acceleration would be slower (the graph would be less steep.
2. The final time (14.2s) will also be increased, as the runners take a longer time to complete the 100m race.